Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

SHOUT
SHARE
IT

LIBRARY
RECEIVED
1923
U. S. Department of Agriculture

UNITED STATES DEPARTMENT OF AGRICULTURE

In Cooperation with the
North Dakota Agricultural Experiment Station

DEPARTMENT BULLETIN No. 1192

Washington, D. C. ▼ November, 1923

IMPROVEMENT OF KUBANKA DURUM WHEAT BY PURE-LINE SELECTION.

By RALPH W. SMITH, *Assistant Agronomist, Office of Cereal Investigations, Bureau of Plant Industry;* L. R. WALDRON, *Plant Breeder, North Dakota Agricultural Experiment Station;* and J. ALLEN CLARK, *Agronomist in Charge of Western Wheat Investigations, Office of Cereal Investigations, Bureau of Plant Industry.*

CONTENTS.

	Page.
History of Kubanka wheat	1
Adaptation	1
Comparative yields	2
Pure-line selections	3
Characters desired	5
Nodak durum wheat	5
Yields of the selections	5
Pure-line selections—Continued.	
Rust resistance	8
Stiffness of straw	9
Semolina qualities	9
Milling and baking qualities	11
Summary	13

HISTORY OF KUBANKA WHEAT.

The Kubanka variety of durum wheat is of Russian origin. Several importations have been made. The principal introduction (S. P. I. No. 5639, C. I. No. 1440 [1]) was made in 1900 by M. A. Carleton, then Cerealist of the United States Department of Agriculture, from Uralsk Territory in Russia. The original seed was grown under contract in 1901, and seed was distributed from then until 1909 by the United States Department of Agriculture and later by the North Dakota and South Dakota Agricultural Experiment Stations.

ADAPTATION.

Kubanka is the most widely adapted variety of durum wheat grown in the United States. It is also the one most extensively grown, with the possible exception of Arnautka. The grain of Kubanka is of good quality for the manufacture of semolina and alimentary pastes, the principal use of durum wheat. Kubanka also is the best durum variety for bread making.

Kubanka is fairly resistant to black stem rust and to drought. It is less resistant to rust than the resistant varieties, Acme, Monad (D–1), and Pentad (D–5). Recent investigations, still unpublished, show that these three wheats are technically inferior to Kubanka in

[1] Accession numbers of the Office of Foreign Seed and Plant Introduction and the Office of Cereal Investigations, Bureau of Plant Industry.

56750—23

the manufacture of macaroni and other alimentary pastes. Kubanka, in the durum-wheat region, has been found to be more resistant to stem rust than Arnautka, Peliss, and Kahla, being about as resistant as Mindum.

COMPARATIVE YIELDS.

In most of the durum-wheat region Kubanka considerably outyields all varieties of hard red spring wheat. It also usually outyields Arnautka, Kahla, Mindum, and Peliss durum wheats in the Dakotas, the principal area of durum wheat production in the United States (fig. 1). It is usually slightly exceeded in yield by Monad, Acme, and Pentad, particularly in years when severe rust epidemics occur.

Table 1 shows the annual and average yields obtained from Kubanka (C. I. No. 1440) and a selection from it, Kubanka No. 8 (C. I. No. 4063), grown at the Dickinson substation, Dickinson, N. Dak., and from Kubanka (C. I. No. 1440) at the North Dakota Agricultural Experiment Station at Fargo, in comparison with the leading varieties of durum and common wheat.

TABLE 1.—*Yields of Kubanka durum wheat and of other leading varieties of durum and common wheats grown at Fargo, N. Dak., and at Dickinson, N. Dak., from 1907 to 1922, inclusive.*

[The varietal experiments at Fargo were affected by excessive rains and weeds in 1905, 1909, and 1912, and yields for these years were not recorded. These varieties were not grown at Fargo in 1915. The crop of 1912 at Dickinson was destroyed by hail. These years are not considered in the respective averages.]

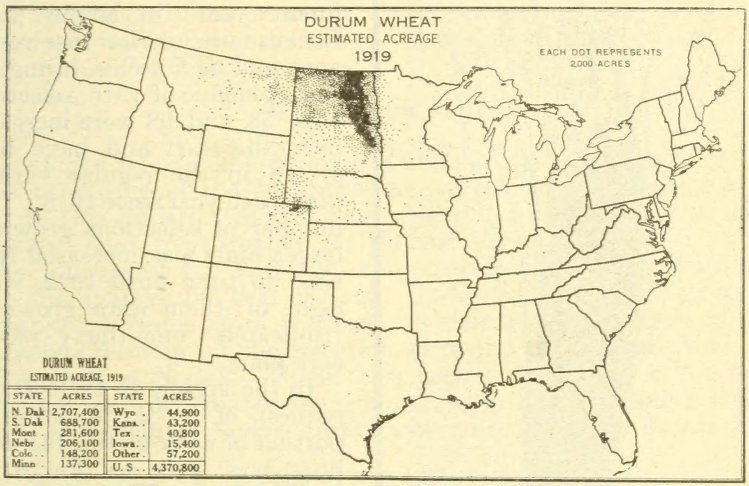
Year.	Annual and average acre yields (bushels).												
	Fargo, N. Dak.						Dickinson, N. Dak.						
	Durum.				Common.		Durum.					Common.	
	Kubanka.	Monad.	Acme.	Mindum.	Power.	Marquis.	Kubanka.	Kubanka, No. 8.	Monad.	Acme.	Mindum.	Rysting.	Marquis.
C. I. No.	1440	3320	5284	5296	3697	3641	1440	4063	3320	5284	5296	3022	3641
1902	28.7	.....	.....	.....	31.9	.....	.....	.....	.....	.....	.....	.....	.....
1903	44.0	.....	.....	.....	42.1	.....	.....	.....	.....	.....	.....	.....	.....
1904	21.9	.....	.....	.....	13.4	.....	.....	.....	.....	.....	.....	.....	.....
1906	24.3	.....	.....	.....	20.0	.....	.....	.....	.....	.....	.....	.....	.....
1907	50.0	.....	.....	.....	26.3	.....	36.0	.....	.....	.....	.....	17.6	.....
1908	38.5	.....	.....	.....	26.2	.....	23.5	.....	.....	.....	.....	22.3	.....
1909	.....	.....	.....	.....	.....	.....	33.7	43.2	.....	.....	.....	33.0	.....
1910	34.3	.....	.....	.....	27.3	.....	14.9	19.9	.....	.....	.....	20.7	.....
1911	14.2	.....	.....	.....	11.0	.....	3.8	3.5	.....	.....	.....	7.7	.....
1913	32.1	.....	.....	.....	29.2	31.7	26.7	31.2	30.9	.....	.....	28.1	24.2
1914	20.3	.....	.....	.....	13.3	21.3	14.2	13.0	13.6	.....	.....	12.4	14.0
1915	.....	.....	.....	.....	.....	.....	46.8	51.5	50.1	.....	.....	25.6	32.8
1916	10.0	.....	.....	.....	4.4	7.6	16.9	17.4	26.2	.....	.....	4.5	13.5
1917	35.9	35.0	34.3	.....	34.7	34.6	20.1	18.7	19.9	18.7	.....	14.4	17.3
1918	39.3	36.7	39.7	.....	26.5	29.1	15.7	18.6	14.6	17.8	14.6	16.9	14.0
1919	17.9	24.9	23.2	.....	10.6	15.7	3.9	4.4	6.4	6.1	4.6	3.8	3.4
1920	17.2	27.6	19.2	26.5	13.2	12.2	23.6	23.2	26.7	23.8	21.1	18.0	15.9
1921	24.5	25.3	26.7	26.8	13.4	19.4	7.1	6.7	8.3	7.5	6.8	3.6	5.6
1922	24.2	41.8	36.8	22.8	14.2	26.6	31.4	30.5	33.2	31.2	29.6	22.5	31.6
Averages:													
1902 to 1922	28.1	.....	.....	.....	21.0	.....	.....	.....	.....	.....	.....	.....	.....
1907 to 1922	.....	.....	.....	.....	.....	.....	21.2	[1] 22.8	.....	.....	.....	16.7	.....
1913 to 1922	24.6	.....	.....	.....	17.7	22.0	20.6	21.5	23.0	.....	.....	15.0	17.2
1917 to 1922	26.5	31.9	30.0	.....	18.8	22.9	17.0	17.0	18.2	17.5	.....	13.2	14.6
1920 to 1922	22.0	31.6	27.6	25.4	13.6	19.4	20.7	20.1	22.7	20.8	19.2	14.7	17.7

[1] Including yields of C. I. No. 1440 in 1907 and 1908.

PURE-LINE SELECTIONS.

Kubanka wheat was chosen as a variety from which to make pure-line selections because of its adaptation to conditions as evidenced by high yields, its value for manufacturing purposes, and its diversity of composition. Kubanka consists of a large number of strains or types differing somewhat in character and quality. Each strain or type breeds true unless it happens to be a hybrid resulting from a field cross. The improvement of Kubanka wheat by the pure-line selection method at the Dickinson substation, Dickinson, N. Dak., is described in this bulletin.

In 1906 Prof. L. R. Waldron, then superintendent of the Dickinson substation, made several pure-line selections from Kubanka (C. I. No. 1440). One of these selections, Kubanka No. 8 (C. I. No. 4063), proved superior in yield to the original Kubanka at Dickinson and



STATE	ACRES	STATE	ACRES
N. Dak	2,707,400	Wyo.	44,900
S. Dak	688,700	Kans.	43,200
Mont.	281,600	Tex.	40,800
Nebr.	206,100	Iowa.	15,400
Colo.	148,200	Other.	57,200
Minn.	137,300	U. S.	4,370,800

FIG. 1.—Map showing the acreage of durum wheat in the United States in 1919. Each dot represents 2,000 acres.

has been quite widely distributed in western North Dakota. Kubanka No. 8, however, has proved to be one of the more rust-susceptible strains of the variety.

With the frequent recurrence of stem-rust damage in North Dakota, it seemed advisable to make additional selections from the bulk Kubanka in an effort to obtain strains resistant to stem rust which would produce good yields of grain suitable for the manufacture of semolina or flour.

In 1915 R. W. Smith made 143 head selections [2] from a plat of Kubanka (C. I. No. 1440) at the Dickinson substation. The separate strains were grown in 5-foot rows at Dickinson in 1916 and in duplicated 16-foot rows in each of the following three years, except that in 1917 some strains were necessarily grown in single rows because of

[2] The making of further selections was jointly planned by Ralph W. Smith and J. Allen Clark. Mr. Clark supervised much of the work and arranged for the milling and baking and the semolina experiments. Mr. Smith conducted all of the experiments at Dickinson with these selections. The experiments in the nursery at Fargo were conducted by L. R. Waldron. The following men, whose cooperation the writers desire to acknowledge, have had charge of the experiments in plats at stations other than Dickinson. T. E. Stoa, at Fargo, N. Dak.; J. C. Brinsmade, jr., at Mandan, N. Dak.; O. A. Thompson, at Edgeley, N. Dak.; and Ralph W. May, at Moccasin, Mont.

FIG. 2.—Heads, chaff, and kernels of Nodak (Kubanka No. 98) durum wheat. Heads and chaff, natural size; kernels magnified 3 diameters.

the limited quantity of seed available. In 1920 the lower yielding strains were discarded, leaving 30 of the higher yielding and more rust-resistant ones. A few of these were discarded after 1921, and the 22 remaining were grown in triplicated 16-foot rows. Kubanka (C. I. No. 1440) was used as a check at regular intervals.

In 1919 19 of the most promising selections were grown in one one-hundred-and-forty-fourth acre plats and in subsequent years in larger plats. Because of superior rust resistance and high yields during the rust epidemic of 1916, selections Nos. 58 and 98 were increased from the start and have been grown in the regular varietal plats each year since 1918. The number of selections grown in larger plats was increased from time to time until 1922, when eight of them were grown in triplicated one-thirty-second acre plats.

In the spring of 1918, at the request of L. R. Waldron, a portion of each of the 143 pure lines was sent to Fargo for testing there. The entire series was grown in 1918 and 1919. In 1918 only individual rows were grown, but in 1919 the rows were replicated. Certain of the more promising selections were grown in replicated rows in the years following and comparable yields obtained. The most promising strains were increased and grown in replicated plats, from which results were recorded in 1921 and 1922. A few of the Kubanka selections were grown in replicated plats in 1922 at the Northern Great Plains Field Station, Mandan, N. Dak., at the Edgeley Substation, Edgeley, N. Dak., and at the Judith Basin Substation, Moccasin, Mont.

Results obtained with different selections grown at any one station are comparable, as they were grown under uniform conditions as to cropping system, date of seeding, size of plat, width of alleys, and number of replications, except as noted. These conditions vary slightly at different stations, so that results obtained at one station are not necessarily comparable with those obtained at another, although the conditions are quite similar.

CHARACTERS DESIRED.

Good yield is only one of several qualities desired in a durum wheat. Rust resistance, stiffness of straw, and good quality for the making of semolina and alimentary pastes are also important. Durum wheat is used only sparingly in the United States at present in the production of flour for bread making. Consequently a study of durum wheats from a bread-making standpoint is of minor importance. Rust resistance is important in determining the yield and quality of grain in years of rust epidemics. Data on all these characters are presented in the following pages.

NODAK DURUM WHEAT.

As shown later in these pages, Kubanka No. 98 is apparently the most promising of the 143 pure-line selections of Kubanka considered in this bulletin, as it combines high yielding ability with rust resistance and good quality for the making of macaroni. It is an amber durum of the Kubanka type, but has heads slightly longer than the average for that variety. It also differs from the original Kubanka in being more resistant to stem rust. Because of these characters, setting off the selection from the parent bulk variety, it is here named Nodak. Under this name it will be further tested, increased, and distributed for commercial growing in North Dakota. Heads and grain of Nodak durum wheat are shown in Figure 2.

YIELDS OF THE SELECTIONS.

Table 2 shows the yields obtained from replicated plats of the Kubanka selections and other varieties of durum wheat during the five years from 1918 to 1922, inclusive, at Dickinson; the two years, 1921 and 1922, at Fargo; and in 1922 only at Mandan and Edgeley, N. Dak., and Moccasin, Mont.

TABLE 2.— *Yields of Kubanka wheat selections and of the leading varieties of durum wheat grown in replicated plats at five experiment stations during one or more of the five years from 1918 to 1922, inclusive.*

[Five plats of each variety were grown at Moccasin and three plats of each at other stations except as noted, duplicate plats being marked with a star (*) and single plats with a dagger (†).]

Strain or variety	C. I. No.	Annual and average acre yields (bushels).											
		Dickinson, N. Dak.					Average.		Fargo, N. Dak.			Mandan, N. Dak.	Edgeley, N. Dak.	Moccasin, Mont.
		1918	1919	1920	1921	1922	1918 to 1922	1921 and 1922	1921	1922	Average.	1922	1922	1922
Kubanka	1440	15.7	3.9	23.6	7.1	31.4	16.3	19.3	24.5	*24.2	24.4	19.6	*20.8	24.8
Kubanka No. 8	4063	18.6	4.4	23.2	6.7	30.5	16.7	18.6	.....	.....	.....	20.0	.....	.....
Kubanka No. 58	6518	†16.0	†4.5	21.1	†6.1	34.4	16.4	20.3	.....	.....	.....	.....	.....	.....
Nodak (Kubanka No. 98)	6519	†18.2	4.4	24.8	6.5	34.9	17.8	20.7	27.5	*33.1	30.3	19.2	*22.8	26.5
Kubanka No. 34	.....	.....	.....	[1] 34.2	[1] *5.5	30.4	.....	18.0	25.6	*22.1	23.9	.....	.....	.....
Kubanka No. 74	.....	.....	.....	[1] 36.5	6.6	31.6	.....	19.1	24.8	*20.6	22.7	19.8	.....	30.7
Kubanka No. 94	.....	.....	.....	[1] 31.5	.....	33.3	.....	.....	28.5	37.5	33.0	.....	*22.8	.....
Kubanka No. 99	.....	.....	.....	[1] 26.5	[1] †6.5	34.2	.....	[1] 20.4	26.3	40.1	33.2	.....	*23.0	.....
Kubanka No. 117	.....	.....	.....	30.5	6.8	33.9	.....	20.4	24.8	35.4	30.1	.....	*27.0	.....
Kubanka No. 132	.....	.....	.....	[1] 35.1	6.8	33.8	.....	20.3	.....	.....	.....	.....	.....	.....
Kubanka No. 133	.....	.....	.....	.....	.....	31.9	.....	.....	21.1	*19.7	20.4	.....	.....	.....
Monad	3320	14.6	6.4	26.7	8.3	33.2	17.8	20.8	25.3	41.8	33.6	20.3	*27.5	26.2
Acme	5284	17.8	6.1	23.8	7.5	31.2	17.3	19.4	26.7	36.8	31.8	18.6	*23.5	27.7
Mindum	5296	†14.6	4.6	21.1	6.8	29.6	15.3	18.2	26.6	22.8	24.7	19.9	.....	.....
Arnautka	4064	16.2	5.2	21.2	7.0	29.2	15.8	18.1	21.1	*18.8	20.0	16.0	*19.5	.....

[1] Not entirely comparable; grown in narrower plats.

Of the selections and varieties grown in plats at Dickinson (figs. 3 and 4) during the 5-year period, Nodak (Kubanka No. 98), averaging 17.8 bushels per acre, yielded the same as Monad and outyielded all other varieties, including the other Kubanka strains. In the 2-year period Kubanka Nos. 99 and 117 yielded nearly as much as Nodak and Monad.

In the two years at Fargo, N. Dak., Kubanka Nos. 99 and 94, averaging 33.2 bushels and 33 bushels, respectively, outyielded Nodak (Kubanka No. 98), the latter averaging 30.3 bushels per acre. In 1922 Nodak was also slightly outyielded by Kubanka No. 74 at Mandan, N. Dak., and Moccasin, Mont., and by Kubanka No. 117 at Edgeley, N. Dak. Yields for one or two years are not conclusive. Results for five years at Dickinson, however, show that Nodak is well adapted to conditions there and probably to similar conditions elsewhere. Results for two years at Fargo indicate that Kubanka No. 99 may yield best in that locality. These results are further borne out by the data in Table 3, where the annual and average yields obtained from replicated nursery rows during six years at Dickinson and four years at Fargo are shown. Nodak ranks high in yield, although not the highest, in the nursery at Dickinson, and Kubanka No. 99 stands high in the nursery at Fargo.

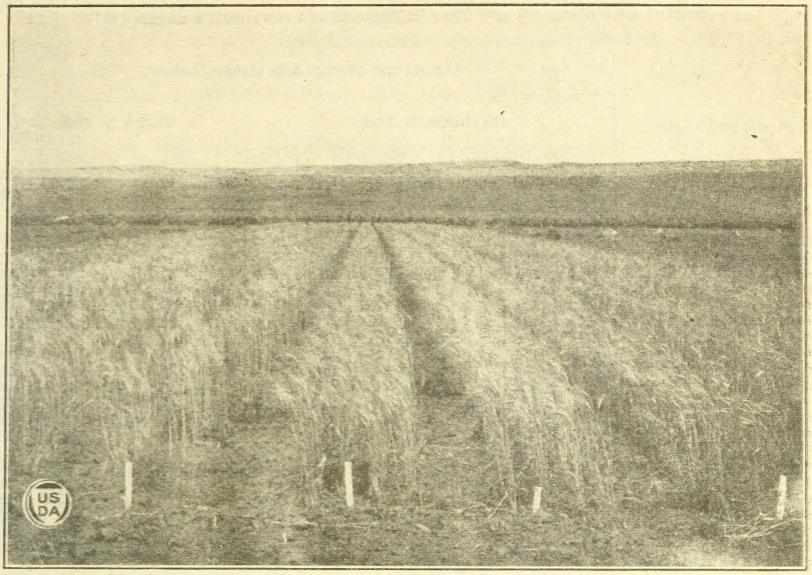


FIG. 3.—Plats of the Kubanka selections at the Dickinson Substation, Dickinson, N. Dak., in 1919.

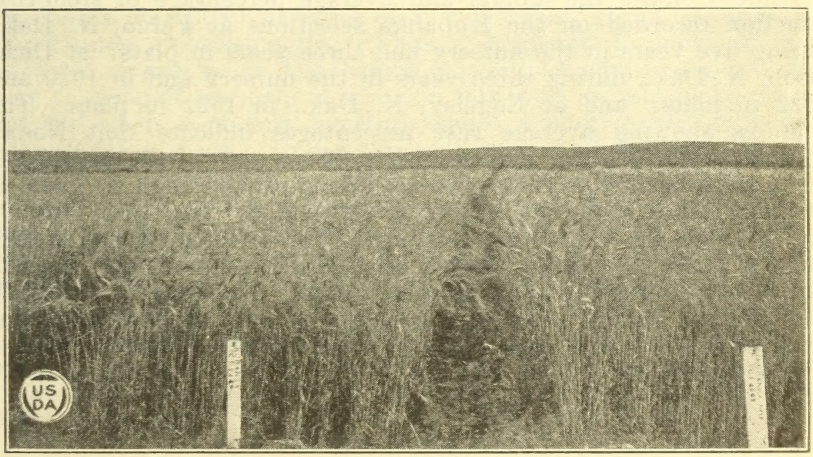


FIG. 4.—Plats of Kubanka wheat, C. I. No. 1440 (left), and Kubanka No. 8, C. I. No. 4063 (right), at Dickinson, N. Dak., in 1917.

TABLE 3.—*Yields of the Kubanka selections grown at Dickinson, N. Dak., from 1917 to 1922 and at Fargo, N. Dak., from 1919 to 1922, inclusive.*

[All selections were grown in replicated 16-foot rows except as noted, those in triplicated 8-foot rows being marked with a star (*) and those in single 16-foot rows with a dagger (†).]

Strain or variety.	Annual and average acre yields (bushels).											
	Dickinson, N. Dak.							Fargo, N. Dak.				
	1917	1918	1919	1920	1921	1922	Average.	1919	1920	1921	1922	Average.
No. 12	†20.0	17.3	1.9	23.8	10.8	19.8	15.6	*17.7	32.7	24.3	29.8	25.6
No. 16	†11.5	16.0	2.9	17.5	12.0	19.1	13.2	*19.2	34.0	27.6	29.6	27.6
No. 26	12.3	12.0	3.5	28.8	12.9	17.5	14.5	*28.1	29.8	29.4	28.7	29.8
No. 34	14.0	22.5	3.5	37.5	14.1	21.5	18.9	*22.9	31.1	24.9	24.4	25.8
No. 45	12.8	19.3	3.2	36.5	12.2	18.2	17.0	*27.6	28.8	28.2	28.9	28.2
No. 55	12.0	18.8	3.2	27.5	16.5	22.5	16.8	*21.8	29.4	26.9	31.4	27.4
No. 58	13.3	18.0	2.8	28.3	16.5	22.8	17.0	.....	.....	.....	.....	.....
No. 63	12.5	17.5	2.0	28.5	13.9	20.5	15.8	*30.8	29.0	30.1	35.9	34.0
No. 64	12.0	20.0	3.3	27.0	13.9	18.9	15.9	*26.4	36.1	26.5	32.4	30.4
No. 65	13.5	20.5	3.1	30.0	14.8	21.0	17.2	*23.0	36.3	26.6	32.5	29.6
No. 74	16.0	21.0	3.6	30.0	16.0	20.8	17.9	*28.5	41.6	24.8	26.6	30.4
No. 75	12.3	18.3	4.2	26.8	12.0	19.2	15.5	*27.8	36.1	26.9	29.6	30.1
No. 94	12.0	16.5	3.3	26.8	13.4	23.2	15.9	*28.0	29.3	24.3	37.2	30.2
No. 97	12.3	[1] 17.1	4.3	28.3	16.7	21.0	16.6	.....	.....	.....	.....	.....
No. 98 (Nodak)	12.8	[1] 17.2	3.0	31.5	14.4	21.6	16.8	*21.4	38.3	27.5	30.0	29.3
No. 99	13.3	18.3	3.6	29.5	14.6	18.2	16.3	*25.8	42.8	26.3	29.8	31.2
No. 109	11.8	18.5	2.3	27.3	10.6	26.3	16.1	*25.5	27.0	26.6	25.2	26.1
No. 111	11.0	13.0	2.0	25.0	11.3	21.2	13.9	*26.1	28.7	27.5	26.2	27.1
No. 115	†11.5	17.5	2.3	27.5	12.9	18.7	15.1	*26.7	35.8	29.6	29.7	30.5
No. 117	12.0	15.5	3.4	27.0	14.1	25.8	16.3	*28.6	30.4	24.4	29.4	28.2
No. 132	†11.0	24.8	4.9	30.8	15.1	22.3	16.5	.....	.....	.....	.....	.....
No. 133	†15.0	16.5	3.6	26.5	13.4	23.3	16.4	*31.4	42.8	26.4	30.6	32.8
C. I. No. 1440	12.6	16.2	2.9	30.6	12.9	19.3	15.8	.....	.....	.....	.....	.....

[1] Seed partly lost; yield estimated from that of C. I. No. 1440.

RUST RESISTANCE.

Table 4 shows the annual and average percentage of stem-rust infection recorded on the Kubanka selections at Fargo, N. Dak., during five years in the nursery and three years in plats; at Dickinson, N. Dak., during three years in the nursery and in 1920 and 1922 in plats; and at Edgeley, N. Dak., in 1922 in plats. The columns showing average rust percentages indicate that Nodak (Kubanka No. 98) and Kubanka No. 99 are two of the most rust-resistant selections. These two selections ranked high in yield at Dickinson and at Fargo, as previously stated. Kubanka Nos. 94 and 117 are also quite rust resistant. The latter produced a high yield at Edgeley in 1922, while both ranked comparatively high in the 2-year average yield in plats at Fargo. Kubanka Nos. 58, 97, and 132 are shown to be very resistant to rust at Dickinson, but were not grown at Fargo. No. 58, which is a red durum, yielded well at Dickinson.

TABLE 4.—*Stem-rust infection recorded on the Kubanka wheat selections in the years during which rust occurred at these stations in North Dakota in the years stated.*

[T=Trace.]

Strain or variety.	Annual and average stem-rust infection (per cent).																
	Dickinson, N. Dak.							Fargo, N. Dak.									Edgeley, N. Dak., plats.
	Nursery.				Plats.			Nursery.						Plats.			
	1920	1921	1922	Average.	1920	1922	Average.	1918	1919	1920	1921	1922	Average.	1921	1922	Average.	1922
No. 12	12	1	10	8	....	....	.....	20	50	5	70	100	49	....	....	.....	.....
No. 16	12	T	10	7	....	....	.....	15	40	5	60	95	43	....	....	.....	.....
No. 26	8	1	8	6	....	....	.....	5	8	5	40	95	31	....	....	.....	.....
No. 34	8	5	9	7	5	12	9	10	10	5	40	93	32	40	85	63	.....
No. 45	8	5	8	7	5	10	8	5	15	5	30	95	30	....	....	.....	.....
No. 55	2	3	5	3	5	....	.....	15	7	0	10	78	22	....	....	.....	.....
No. 58	2	1	5	3	1	1	1	....	....	....	....	....	....	....	....	.....	.....
No. 63	4	2	11	6	4	....	.....	10	47	5	60	95	43	....	85	.....	.....
No. 64	4	1	8	4	4	....	.....	10	70	8	60	95	49	....	....	.....	.....
No. 65	3	1	14	6	6	14	10	10	5	0	40	95	30	....	....	.....	.....
No. 74	2	1	12	5	5	10	8	10	18	5	60	95	38	35	90	63	.....
No. 75	3	1	14	6	8	....	.....	40	7	13	60	95	43	....	....	.....	.....
No. 94	3	T	6	3	3	6	5	5	22	0	5	53	17	3	20	12	11
No. 97	2	T	5	2	1	6	4	....	....	....	....	....	....	....	....	.....	.....
No. 98 (Nodak)	1	T	5	2	1	4	3	5	7	0	5	23	8	2	40	21	13
No. 99	2	T	5	2	....	3	.....	5	5	0	1	18	6	2	15	9	12
No. 109	6	1	13	7	12	....	.....	13	43	8	70	78	42	....	....	.....	.....
No. 111	3	T	10	4	....	....	.....	5	7	5	10	53	16	....	....	.....	.....
No. 115	4	1	11	5	....	....	.....	10	57	8	60	83	44	....	....	.....	.....
No. 117	3	1	5	3	3	4	4	5	7	0	10	18	8	3	30	17	7
No. 132	1	T	6	2	1	3	2	....	....	....	....	....	....	....	....	.....	.....
No. 133	3	1	8	4	....	9	.....	10	27	5	60	95	39	55	85	70	.....
C. I. No. 1440	7	1	12	7	7	5	6	12	141	8	50	95	41	45	85	65	27
Monad	4	T	5	3	T	T	T	5	1	2	2	11	4	2	25	14	3

[1] Average of 143 pure-line selections.

STIFFNESS OF STRAW.

Kubanka, like other varieties of durum wheat, grows tall and has heavy heads. Consequently, it has a tendency to lodge if rain and wind storms occur just before harvest. Lodging is especially likely to occur if the crop is sown on fallow or on unusually fertile land and when abundant moisture causes a rank growth of straw and well-filled heads. Under the conditions prevailing at Dickinson, N. Dak., lodging has not often been a serious factor, and no percentages were recorded, although some notes on lodging were taken. Considerable lodging occurred at Fargo in 1920 and 1922. Percentages of lodging were recorded on the Kubanka selections in the nursery in 1920 and in the plats in 1922. The results show Nodak to be slightly weak in straw, ranking about the same in that respect as Monad and slightly better than Acme. Selection No. 99 has a medium strength of straw, being a little stiffer than Monad and Acme. Selections Nos. 63, 74, and 133 have comparatively stiff straw.

SEMOLINA QUALITIES.

As a large part of the durum wheat grown in this country is made into semolina for the production of macaroni and other edible pastes, the varieties of this wheat which are grown should possess the qualities demanded by that industry in addition to those already mentioned. The semolina industry demands a durum wheat which

will make macaroni and other edible pastes that are of a yellowish color and hard and vitreous, retaining their form after cooking. It has been found that durum wheats producing a hard vitreous product have a high protein content and yield a semolina of comparatively high ash content. The protein content no doubt has an important connection with the quality and character of the macaroni product, but the ash content probably is of no significance except as it may be associated with some other factor that is of importance.

TABLE 5.—*Average crude protein, ash, and gasoline color data recorded on flour made from Kubanka selections and durum wheat varieties grown at Dickinson, N. Dak., and at Fargo, N. Dak., in the years stated.*

[Data from the research laboratory, Grain Division, Bureau of Agricultural Economics.]

Strain or variety.	Crude protein (N. × 5.7) in flour (per cent).			Ash in flour (per cent).			Gasoline color score of flour.		
	Dickinson, 1920 to 1922.	Fargo, 1921 and 1922.	Average.	Dickinson, 1920 to 1922.	Fargo, 1921 and 1922.	Average.	Dickinson, 1920 to 1922.	Fargo, 1921 and 1922.	Average.
Kubanka No. 8	18.0			0.83			1.62		
Kubanka No. 34	18.5	14.4	16.5	1.02	1.05	1.04	1.61	2.00	1.81
Kubanka No. 58	17.7			.96			2.12		
Kubanka No. 74	18.4	14.8	16.6	1.04	1.13	1.09	1.72	2.09	1.91
Kubanka No. 94	17.2	15.7	16.5	.99	1.14	1.07	1.24	1.29	1.27
Nodak (Kubanka No. 98)	18.4	16.7	17.6	1.05	1.18	1.12	1.45	1.46	1.46
Kubanka No. 99	17.8	16.4	17.1	1.08	1.21	1.15	1.32	1.30	1.31
Kubanka No. 117	18.1	16.8	17.5	1.06	1.16	1.11	1.39	1.17	1.28
Kubanka No. 132	17.2			.96			1.75		
Kubanka No. 133	17.4	14.0	15.7	1.03	1.20	1.12	1.88	2.34	2.11
C. I. No. 1440	18.5	14.9	16.7	1.04	1.11	1.08	1.67	1.94	1.81
Monad	16.7	16.8	16.8	.85	1.03	.94	1.06	1.02	1.04
Acme	[a] 16.5	[b] 11.8	[c] 14.2	[a] .91	[b] .80	[c] .86	[a] 1.67	[b] .69	[c] 1.18
Mindum	17.9			.89			1.68		

[a] Data for 1920 and 1922 only. [b] Data for 1921 only. [c] Not comparable.

Table 5 shows the average data on crude protein, ash content, and gasoline color value [3] of flour obtained by the research laboratory of the Bureau of Agricultural Economics [4] from the Kubanka selections and other durum varieties grown at Dickinson, N. Dak., in the three years, 1920, 1921, and 1922, and at Fargo in the two years, 1921 and 1922. Nodak (Kubanka No. 98) ranks highest in crude protein and second in ash content, averaging 17.6 per cent and 1.12 per cent, respectively, for those constituents. It is medium in gasoline color, averaging 1.46. Kubanka No. 99 ranks third in crude protein and first in ash content, with averages of 17.1 per cent and 1.15 per cent, respectively, and averages 1.31 in gasoline color. Kubanka No. 74 is medium in both crude protein and ash content and high in the color test, averaging 1.91 in the latter. Kubanka No. 133, averaging 2.11, gave the highest average gasoline color test for the two stations and was second in ash content. Kubanka No. 34 is also high in color value. Kubanka No. 58, a red durum selection grown at Dickinson, gave the highest gasoline color score for that station, averaging 2.12 for the 3-year period.

[3] The gasoline color test is considered the best practical method of determining the color value of a durum wheat for macaroni manufacture, aside from actually making the macaroni. The North Dakota Agricultural Experiment Station has recently milled different varieties of durum wheat into semolina, and the samples have been manufactured into macaroni by commercial companies. The finished product from the different varieties shows remarkable variat on in color and appearance and indicates clearly the importance of securing a variety possessing suitable characters before it is recommended for distribution.

[4] The semolina experiments were conducted by D. A. Coleman and Alfred Christie, jr., of the research laboratory, Grain Division, Bureau of Agricultural Economics, to whom the writers of this bulletin are indebted for the results here reported.

A milling company at Minneapolis, Minn., has found the Pekar test for color to be practicable for determining color values and shade of semolinas. A light yellow or amber is the color which they prefer. Samples of several of the Kubanka selections and durum-wheat varieties were furnished that milling company for the making of this test. The data are given in Table 6.

The results show that Nodak (Kubanka No. 98) has the desired shade. Its score is about equal to that of the original Kubanka, Kubanka No. 8, and Mindum and is better than that of the other selections and varieties.

TABLE 6.—*Score and shade of Pekar test for color recorded on semolina made from Kubanka selections and durum-wheat varieties grown at Fargo, N. Dak., in 1921 and 1922 and at Dickinson, N. Dak., in 1922.*

[Data from a milling company at Minneapolis, Minn.]

Selections and varieties.	Score.			Shade.		
	Fargo.		Dickinson.	Fargo.		Dickinson.
	1921	1922	1922	1921	1922	1922
Kubanka No. 8			98			Light yellow.
Kubanka No. 34	99		97	Bright yellow		Pale yellow.
Kubanka No. 58			96			Brown-yellow.
Kubanka No. 74	99		97	Bright yellow		Pale yellow.
Kubanka No. 94	78		85	Dull brown		Dull yellow.
Nodak (Kubanka No. 98).	98	97	98	Light yellow	Light yellow	Light yellow.
Kubanka No. 99	80	85	95	Dull gray	Dull yellow	Gray yellow.
Kubanka No. 117	80		85	do		Dull yellow.
Kubanka No. 132			97			Pale yellow.
Kubanka No. 133	100		94	Very bright yellow		Brown-yellow.
Kubanka (C. I. No. 1440).	98	100	97	Light yellow	Light yellow	Pale yellow.
Monad		85	85		Dull yellow	Dull gray.
Acme		85	85		do	Do.
Mindum		99	97		Light yellow	Pale yellow.

MILLING AND BAKING QUALITIES.

Little or no durum-wheat flour is used alone for bread making. Most of that used in bread making is blended with flour from other classes of wheat. Durum wheats generally have a higher bushel weight than a common wheat like Marquis. Correlated with this higher bushel weight the durum wheats produce a slightly greater yield of flour, on the average, than the common wheats. Durum-wheat flour contains more gluten, on the average, than common wheat flour, but this gluten is of inferior quality. Bread made from durum wheat has an agreeable flavor, but has a smaller loaf volume and scores somewhat lower in color than bread made from standard red spring wheats. The loaf volume and color of crumb from Kubanka wheat average better than those from most other durum varieties.

Milling and baking experiments were conducted with the best of the Kubanka selections and a few standard durum varieties grown at Dickinson, N. Dak., during the three years from 1920 to 1922 and at Fargo, N. Dak., in 1921 and 1922.[5] The more important milling and

[5] The milling and baking experiments with wheat grown in 1920 were conducted by the milling laboratory of the North Dakota Agricultural Experiment Station. The milling and baking experiments with wheat grown in 1921 and 1922 were conducted by the Milling Investigations Section, Grain Division, Bureau of Agricultural Economics.

baking results are presented in Table 7, which shows the average data for the 3-year period at Dickinson and for the two years at Fargo and also the average for each selection or variety at the two stations. Kubanka No. 99 showed the highest average yield of flour produced in comparable tests, followed by Nodak. The volume of loaf of these two selections is not high. Kubanka No. 74 ranked highest among the durums in average loaf volume and highest of all varieties, including Marquis and Kota, in texture of crumb.

TABLE 7.—*Average milling and baking data obtained from the Kubanka selections and durum varieties grown at Dickinson, N. Dak., in 1920, 1921, and 1922 and at Fargo, N. Dak., in 1921 and 1922.*

[Data on 1920 crop from the milling laboratory of the North Dakota Agricultural Experiment Station; those on the 1921 and 1922 crops from the Milling Investigations Section, Grain Division, Bureau of Agricultural Economics.]

Strain or variety.	Bushel weight (pounds).			Milling yield of flour (per cent).		
	Dickinson, 3 years.	Fargo, 2 years.	Average.	Dickinson, 3 years.	Fargo, 2 years.	Average.
Kubanka No. 8	59.3	.....	.....	74.9	.....	.....
Kubanka No. 34	60.4	56.2	58.3	75.5	69.0	72.3
Kubanka No. 58	.....	.....	.....	72.4	.....	.....
Kubanka No. 74	59.9	55.6	57.8	75.6	71.1	73.4
Kubanka No. 94	.....	59.1	.....	[1] 76.7	72.9	[2] 74.8
Kubanka No. 98 (Nodak)	59.3	58.1	58.7	73.4	74.8	74.1
Kubanka No. 99	60.7	58.8	59.8	74.7	74.0	74.4
Kubanka No. 117	60.8	57.6	59.2	74.6	69.9	72.3
Kubanka No. 132	61.4	.....	.....	76.0	.....	.....
Kubanka No. 133	.....	52.6	.....	[3] 79.1	68.0	[2] 73.6
Kubanka (C. I. No. 1440)	60.1	56.6	58.4	73.9	69.6	71.8
Monad (C. I. No. 3320)	60.3	58.9	59.6	73.1	.....	.....
Acme (C. I. No. 5284)	60.4	60.0	60.2	73.8	.....	.....
Mindum (C. I. No. 5296)	60.3	57.9	59.1	77.3	.....	.....
Marquis (C. I. No. 3641)	57.7	54.5	56.1	70.1	69.1	69.6
Kota (C. I. No. 5878)	59.6	57.7	58.7	73.7	72.5	73.1

Baking results.

Strain or variety.	Loaf volume (c. c.).			Texture of crumb (score).			Color of crumb (score).		
	Dickinson, 3 years.	Fargo, 2 years.	Average.	Dickinson, 3 years.	Fargo, 2 years.	Average.	Dickinson, 3 years.	Fargo, 2 years.	Average.
Kubanka No. 8	1,917	.....	.....	90.7	.....	.....	89.7	.....	.....
Kubanka No. 34	1,937	2,110	2,024	92.8	93.2	93.0	91.3	85.0	88.2
Kubanka No. 58	1,990	.....	.....	92.5	.....	.....	88.5	.....	.....
Kubanka No. 74	2,096	2,055	2,076	94.7	95.7	95.2	91.7	85.5	88.6
Kubanka No. 94	.....	1,945	.....	.....	90.5	.....	.....	87.8	.....
Kubanka No. 98 (Nodak)	1,842	1,975	1,909	86.3	88.0	87.2	88.0	85.7	86.9
Kubanka No. 99	1,858	1,860	1,859	88.5	88.4	88.5	90.0	86.2	88.1
Kubanka No. 117	1,930	1,975	1,953	91.1	90.5	90.8	91.0	87.5	89.3
Kubanka No. 132	1,930	.....	.....	92.0	.....	.....	91.2	.....	.....
Kubanka No. 133	.....	1,975	.....	.....	88.5	.....	.....	83.9	.....
Kubanka (C. I. No. 1440)	1,903	2,100	2,002	90.4	91.0	90.7	90.2	86.7	88.5
Monad (C. I. No. 3320)	1,800	.....	.....	91.2	.....	.....	88.7	.....	.....
Acme (C. I. No. 5284)	1,908	.....	.....	89.8	.....	.....	89.0	.....	.....
Mindum (C. I. No. 5296)	1,743	.....	.....	90.4	.....	.....	88.3	.....	.....
Marquis (C. I. No. 3641)	2,357	2,345	2,351	89.2	88.3	88.8	92.0	90.4	91.2
Kota (C. I. No. 5878)	2,243	2,255	2,249	90.7	90.2	90.6	89.5	89.3	89.4

[1] Average for two years only. [2] Not entirely comparable. [3] Data for one year only.

SUMMARY.

Kubanka is superior to each of the other varieties of durum wheat in one or more important characters.

From a head selection made in 1906 from Kubanka (C. I. No. 1440) at the Dickinson substation, Kubanka No. 8 (C. I. No. 4063) was developed. This strain ranks high in quality and in yield under rust-free conditions, but is somewhat more susceptible to rust than the original Kubanka.

One hundred and forty-three head selections were made from Kubanka (C. I. No. 1440) at the Dickinson substation in 1915. The best of these have been grown at Dickinson during the past seven years in the nursery and five years in plats; at Fargo, N. Dak., during five years in the nursery and two years in plats; and at Mandan, N. Dak., Edgeley, N. Dak., and Moccasin, Mont., for one year in plats.

TABLE 8.—*Average data obtained on yield, stem-rust infection, and gasoline color score of the Kubanka selections and durum-wheat varieties grown at Dickinson, N. Dak., during the years from 1917 to 1922 and at Fargo, N. Dak., during the years from 1918 to 1922, inclusive.*

Strain or variety.	Acre yield (bushels).				Stem-rust infection (per cent).			Gasoline color score.		
	Dickinson.		Fargo.		Dickinson.	Fargo.	Average.	Dickinson, 3 years.	Fargo, 2 years.	Average.
	Plats, 2 years.	Nursery, 6 years.	Plats, 2 years.	Nursery, 5 years.	Nursery, 3 years.	Nursery, 5 years.				
Kubanka No. 8	18.6	.....	.....	.....	7	.....	.....	1.62	.....	.....
Kubanka No. 34	18.0	18.0	23.9	30.9	7	22	19.5	1.61	2.00	1.81
Kubanka No. 58	20.3	17.0	.....	.....	3	.....	.....	2.12	.....	.....
Kubanka No. 74	19.1	17.9	22.7	34.1	5	38	21.5	1.72	2.09	1.91
Kubanka No. 94	.....	15.9	33.0	31.7	3	17	10.0	1.24	1.29	1.27
Kubanka No. 98 (Nodak)	20.7	16.8	30.3	31.2	2	8	5.0	1.45	1.46	1.46
Kubanka No. 99	[a] 20.4	16.3	33.2	37.4	2	6	4.0	1.32	1.30	1.31
Kubanka No. 117	20.4	16.3	30.1	34.2	3	8	5.5	1.39	1.17	1.28
Kubanka No. 132	20.3	16.5	.....	.....	2	.....	.....	1.75	.....	.....
Kubanka No. 133	.....	16.4	20.4	35.1	4	39	21.5	1.88	2.34	2.11
Kubanka (C. I. No. 1440)	19.3	15.8	24.4	.....	7	40	23.5	1.67	1.94	1.81
Monad (C. I. No. 3320)	20.8	.....	33.6	.....	[a] 3	.....	.....	1.06	1.02	1.04
Acme (C. I. No. 5284)	19.4	.....	31.8	.....	[a] 5	.....	.....	[a] 1.67	[a] .69	[a] 1.18
Mindum (C. I. No. 5296)	18.2	.....	24.8	.....	[a] 10	.....	.....	1.68	.....	.....

[a] Not entirely comparable.

The most important results obtained from these experiments are summarized in Table 8, which shows the average data obtained at Dickinson and Fargo on grain yield[6] and on stem-rust infection and the average gasoline color score of flour made from grain grown at these two stations.

[6] Table 2 shows 5-year average yields at Dickinson, N. Dak. Table 7 shows the average yield for only two years, as some of the selections were grown for only two years in the larger plats. The results for a longer period in smaller plats agree closely with the results shown in Table 8.

Nodak (Kubanka No. 98) equaled Monad at Dickinson in the 5-year average yield in plats and outyielded all the other selections and varieties. This selection was very resistant to rust at both stations. It is slightly weak in straw, ranking with Monad in this respect. In semolina qualities it ranked highest of the four rust-resistant strains. It ranked first in crude protein and about medium in gasoline color value, averaging 17.6 and 1.46 per cent, respectively, for these qualities. It has a high color score and the desired light-yellow shade, as determined by the Pekar test. It ranked slightly above the average in yield of flour and slightly below the average in loaf volume. Because of the greater advantages of Nodak (Kubanka No. 98) over the other selections it has been named and seed increased at the Dickinson substation, where more than 200 bushels of seed were grown in 1922.

Kubanka No. 99 outyielded all other selections at Fargo in both the plats and the nursery and almost equaled Monad in yield. It yielded comparatively high at Dickinson. It ranks with Monad in rust resistance and is slightly better in strength of straw. In semolina qualities it has an average score of 17.1 per cent in crude protein and 1.31 in color value, being slightly below Nodak in these qualities, although considerably above Monad and Acme in color and slightly better in crude protein. Kubanka No. 99 is above the average in yield of flour and slightly below the average in loaf volume.

Kubanka No. 74 did not yield especially well in the plats at Dickinson and Fargo, although in the nursery it ranked first at Dickinson and yielded well at Fargo. It also yielded well in the 1-year tests at Mandan and Moccasin. It is not especially rust resistant, but is early and has stiff straw. It ranks high in color score for semolina and is good in milling and baking qualities.

Kubanka No. 133 was only medium in yield and rust resistance, but has stiff straw and averaged very high in color value for semolina.

Kubanka No. 58, a red durum grown only at Dickinson, has yielded fairly well, is very rust resistant, fairly good in milling and baking qualities, and unusually high in color score for semolina.

Monad ranked first in yield at Fargo and tied with Nodak for first place in the 5-year average yield at Dickinson. Acme yielded slightly less than Monad at both places. The North Dakota Agricultural Experiment Station has milled semolina from the crop of the Monad and Acme varieties for one year, and macaroni has been made from it. The macaroni from both these varieties is inferior in color.

Nodak (Kubanka No. 98) combines high-yielding ability, rust resistance, and good quality for the making of macaroni. It apparently is the most promising selection or variety for North Dakota and will be increased and distributed for commercial growing in that State.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.

October 22, 1923.

Secretary of Agriculture	HENRY C. WALLACE.
Assistant Secretary	HOWARD M. GORE.
Director of Scientific Work	E. D. BALL.
Director of Regulatory Work	WALTER G. CAMPBELL.
Director of Extension Work	C. W. WARBURTON.
Weather Bureau	CHARLES F. MARVIN, *Chief.*
Bureau of Agricultural Economics	HENRY C. TAYLOR, *Chief.*
Bureau of Animal Industry	JOHN R. MOHLER, *Chief.*
Bureau of Plant Industry	WILLIAM A. TAYLOR, *Chief.*
Forest Service	W. B. GREELEY, *Chief.*
Bureau of Chemistry	C. A. BROWNE, *Chief.*
Bureau of Soils	MILTON WHITNEY, *Chief.*
Bureau of Entomology	L. O. HOWARD. *Chief.*
Bureau of Biological Survey	E. W. NELSON, *Chief.*
Bureau of Public Roads	THOMAS H. MACDONALD, *Chief.*
Bureau of Home Economics	LOUISE STANLEY, *Chief.*
Fixed Nitrogen Research Laboratory	F. G. COTTRELL, *Director.*
Division of Accounts and Disbursements	A. ZAPPONE, *Chief.*
Library	CLARIBEL R. BARNETT, *Librarian.*
Federal Horticultural Board	C. L. MARLATT, *Chairman.*
Insecticide and Fungicide Board	J. K. HAYWOOD, *Chairman.*
Packers and Stockyards Administration *Grain Future Trading Act Administration*	CHESTER MORRILL, *Assistant to the Secretary.*
Office of the Solicitor	R. W. WILLIAMS, *Solicitor.*

This bulletin is a contribution from

Bureau of Plant Industry	WILLIAM A. TAYLOR, *Chief.*
Office of Cereal Investigations	CARLETON R. BALL, *Cerealist in Charge.*

ADDITIONAL COPIES
OF THIS PUBLICATION MAY BE PROCURED FROM
THE SUPERINTENDENT OF DOCUMENTS
GOVERNMENT PRINTING OFFICE
WASHINGTON, D. C.
AT
5 CENTS PER COPY

PURCHASER AGREES NOT TO RESELL OR DISTRIBUTE THIS COPY FOR PROFIT.—PUB. RES. 57, APPROVED MAY 11, 1922

▽